South African Extreme Wind Atlas (WASA)

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WASA Project Team

- **SANEDI** *(South African National Energy Development Institute)*
  - executing agency – contracting the implementing partners
  - coordination and dissemination
- **UCT CSAG** *(Climate System Analysis Group, University of Cape Town)*
  - mesoscale modelling
- **CSIR** *(Built Environment, Council for Scientific and Industrial Research)*
  - measurements and microscale modelling
- **SAWS** *(South African Weather Service)*
  - extreme wind assessment
- **DTU Wind Energy*** *(Dept of Wind Energy, Technical University of Denmark)*
  - partner in all activities

** the original DTU partner (Risø DTU) is part of DTU Wind Energy established Jan 2012*

WP5 – Extreme Winds
Why do we need extreme wind statistics?

- Wind constitutes most critical environmental loading affecting structural design of built environment in South Africa;
- Information on extreme winds essential in the design of wind farms – situated in areas with relatively strong winds;
- Therefore development of relevant extreme wind information essential in planning of large-scale exploitation of wind power in South Africa.

Origins of strong winds

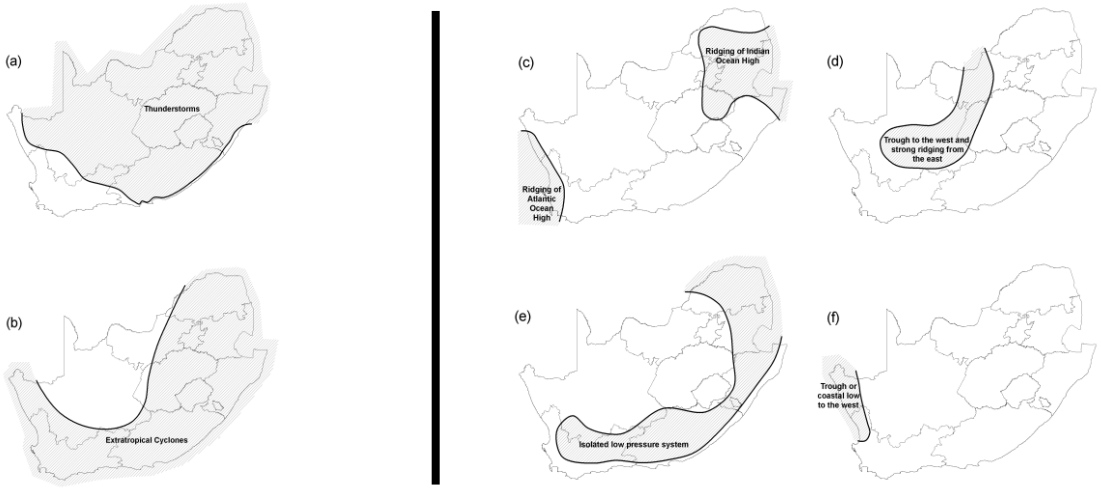
•Interior: thunderstorm dominated;

•Coast, adjacent interior – extratropical cyclone (cold front) dominated;

•Larger part of South Africa – mixed strong wind climate…

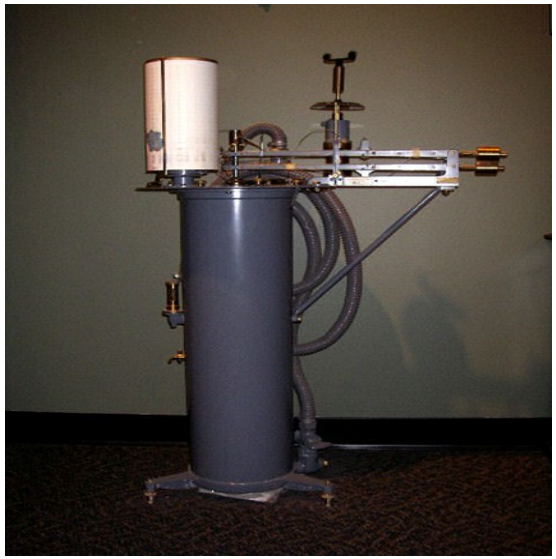
Zoning of Extreme Wind Causes / Mechanisms

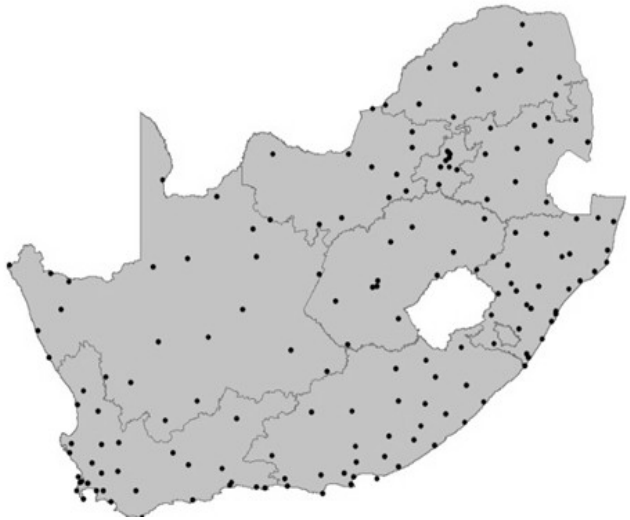
Primary Causes *Secondary Causes*



Effect of Mixed Strong Wind Climate

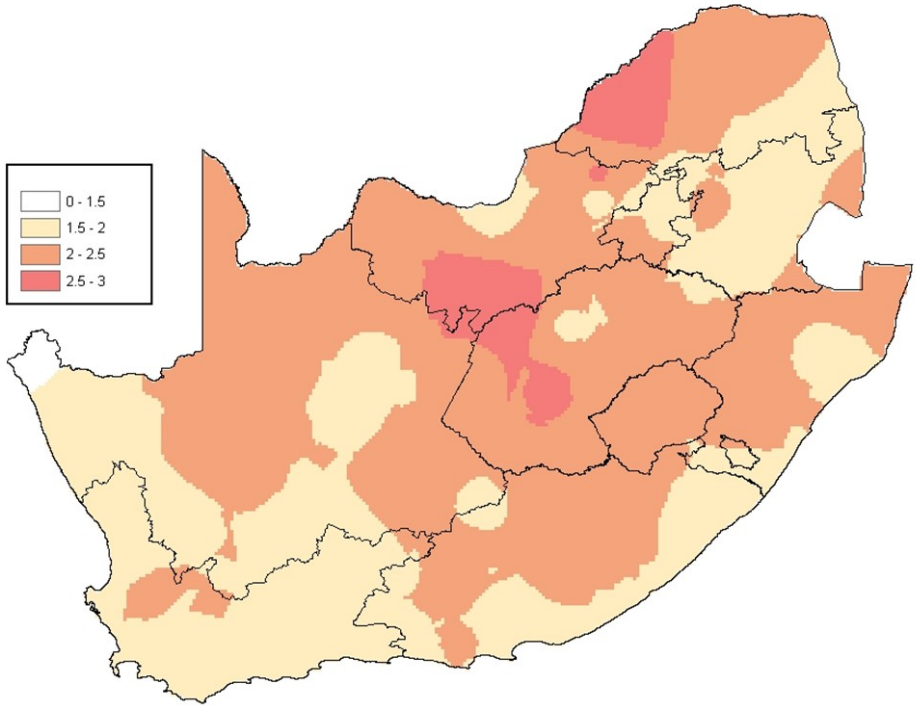
- In interior cause of strong winds can be synoptic and/or mesoscale (thunderstorms);
- Effect on optimal estimation of design wind speeds (especially gusts);
- Ratios between 1:50 yr wind values at different time periods varies across South Africa - complicates conversion between time periods;
- Measured data to form basis of development of extreme wind statistics.





Time resolutions of extreme wind statistics

- Statistics of extreme winds can be provided for different time resolutions, e.g. 10 min, 2-3 sec (gusts) etc.
- Standard factors enable conversion between time periods;
- Fixed factors impossible in mixed climate environment;



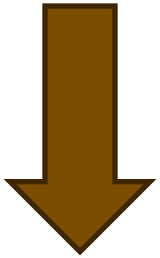
- Necessary to provide statistics for different time resolutions.

Optimal development of design wind speed statistics

A. Statistical extraction of extreme wind observations from reanalysis and model data:

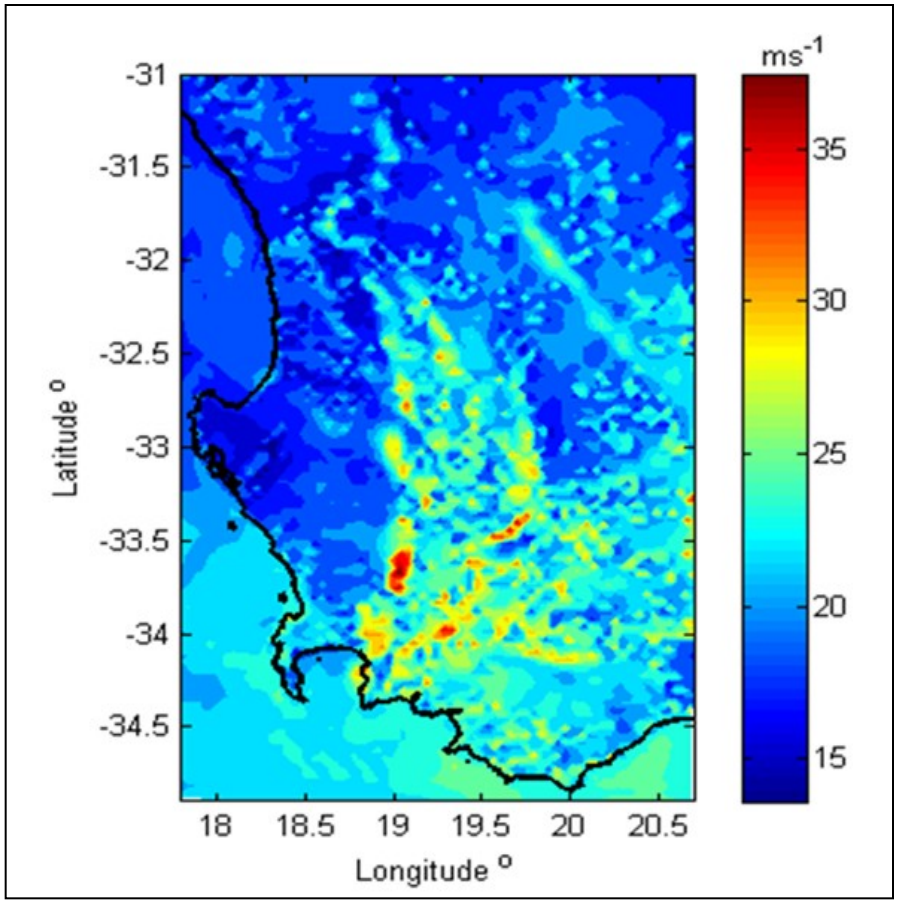
- High spatial resolution possible;
- New methods continuously researched:

Low time-resolution data (e.g. 6-hourly wind speed)



High time-resolution statistics (e.g. 1:50 yr 10 min wind speed)

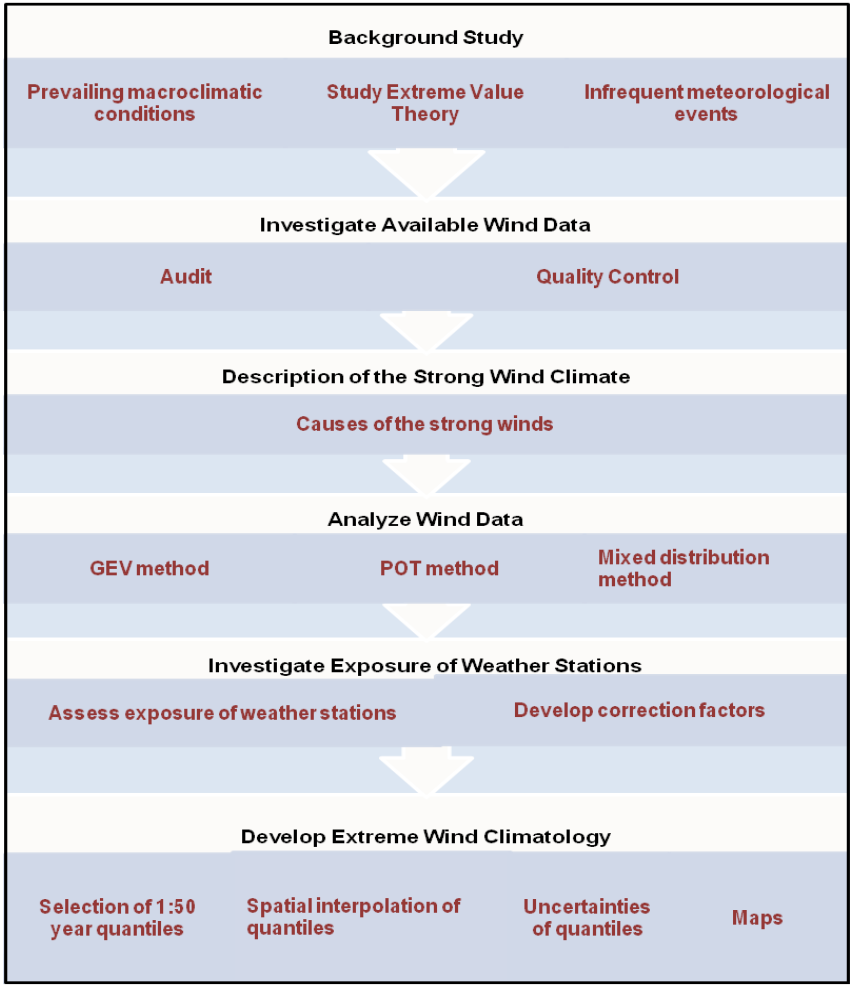
- Temporal variability is missed out by smoothing effect of numerical modelling;
- Only applicable to regions with exclusively synoptic strong wind mechanisms, e.g. SW Cape.



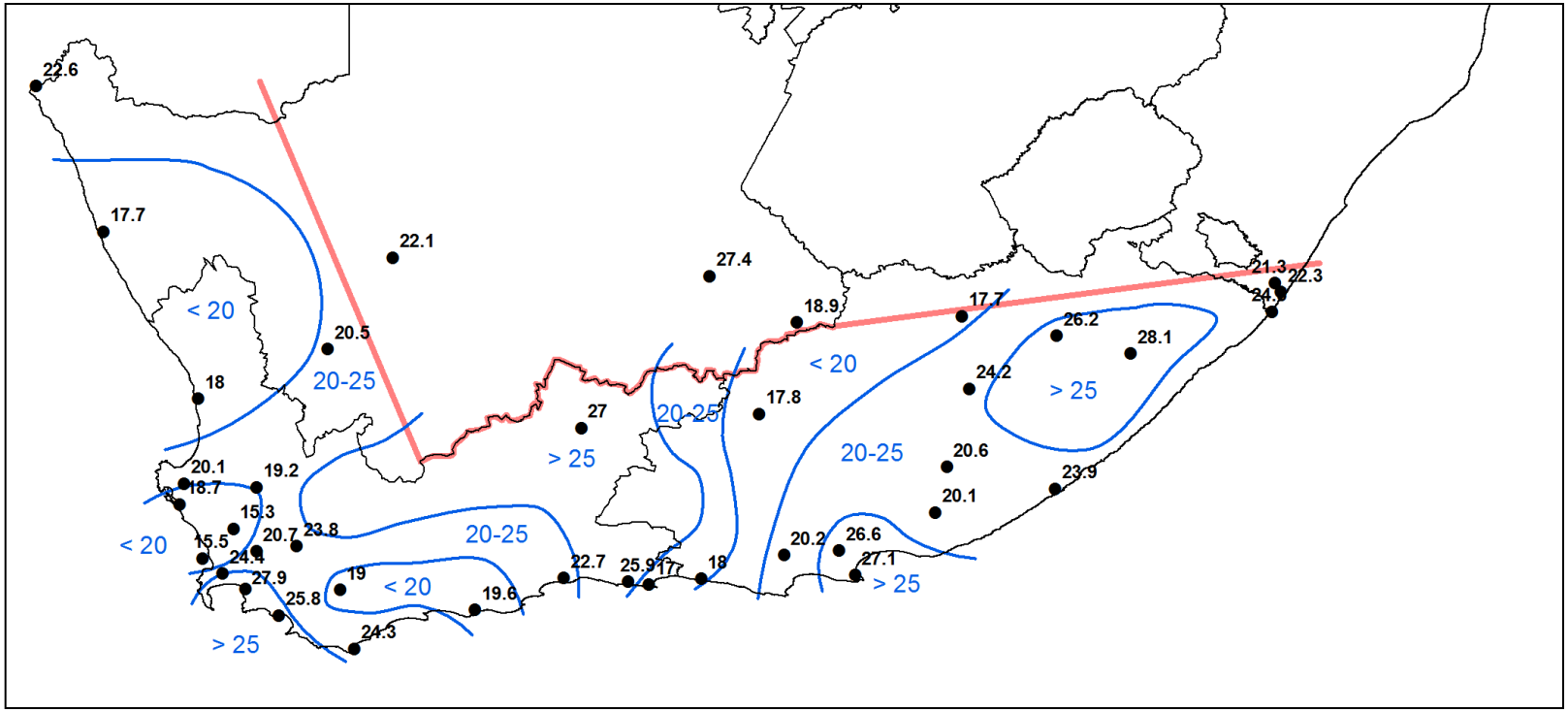
1:50 yr 10-min wind speed for SW Cape for level terrain

2. Analysis of measured data

- Types of instrument, measuring environment and record lengths to be considered.

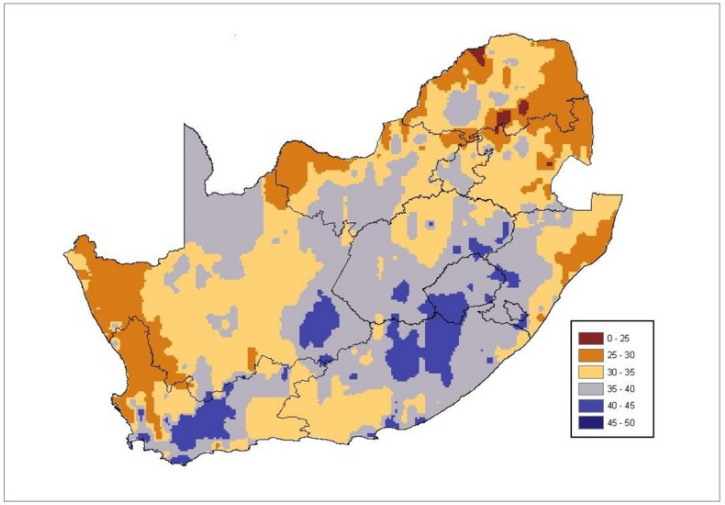


- Compatible with mixed strong wind climates using appropriate statistical techniques;
- Low resolution – planned wind farms in remote areas not sufficiently covered by long-term measurements.

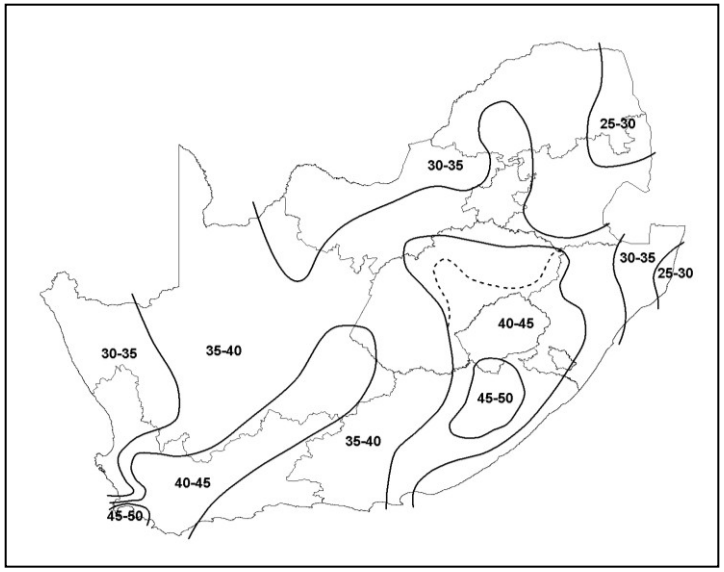


1:50 yr 10-min wind speed for WASA project area

1:50 year gust estimations from observed data.



1:50 year gust map with adjustments for uncertainty.



- Refinement of final maps to be done through integration of results from measured and model data

Application of extreme wind statistics for wind farm planning

- IEC (International Electrotechnical Commission) 61400 - class of international standards for wind turbines;
- Ensure that wind turbines are appropriately engineered against damage from hazards within planned lifetime;
- Wind Turbine Classes:
  - Determine which turbine is suitable for wind conditions of particular site;
  - During construction and design phase assumptions made about local wind climate that wind turbines will be exposed to;
    - Vref – 1:50 yr 10 min average speed at hub height,
    - A, B & C: Reference turbulence intensities.

Turbine Class	IEC I High Wind	IEC II Med Wind	IEC III Low Wind
Vref	50 m/s	42,5 m/s	37,5 m/s
A		0,16	
B		0,14	
C		0,12	

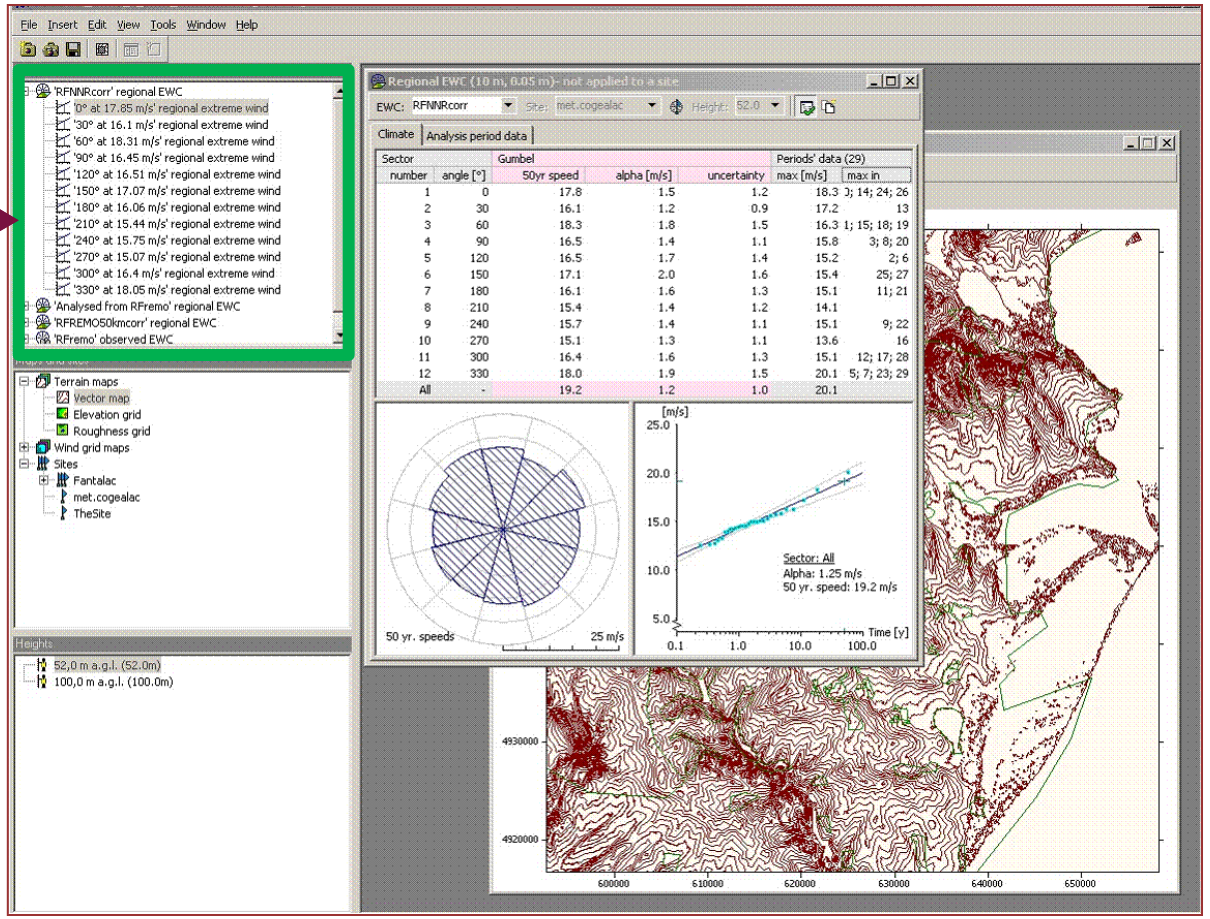
IEC standard and WAsP Engineering

WAsP Engineering: Software to compute extreme winds and parameters for IEC standard (e.g. Vref, Iref) at a particular site, with local environment & topography and Region Extreme Wind Climate (REWC) as input.

REWC obtained from:

- Observations
- Global reanalysis data (e.g. NCEP/NCAR, ERA-40, CFSR)
- Mesoscale model simulations
  - Climate simulation
  - Storm episode method
  - Extreme wind class method

(the above statistics to be integrated in the WASP work package on extreme winds)



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WASA Phase I Final Wind Seminar

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